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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

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Electric Railway Lubrication

The Relation of Lubrication to Power Economy

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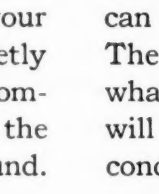

THERE IS A TEXACO LUBRICANT FOR EVERY PURPOSE

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Electric Railway Lubrication

The Relation of Lubrication to Power Economy

OF the factors which may be involved in operation and maintenance of virtually any type of machinery, power consumption is, in all probability, of most interest to the operator. There is a direct tie-up between power consumption and lubrication, in view of the fact that upon this latter will depend the degree to which friction will be reduced.

Power must be consumed by any machine, whether it be a power generating device such as a steam turbine, a producing element such as a machine tool or a medium of transportation such as an electric railway car. Wherever bearings, speed reducing or power transmission elements are involved, friction may develop into a potential hindrance to efficient operation. Hence the necessity for lubrication.

Research and intensive test work in actual practice have proven that a reduction of friction and wear can be materially brought about by more careful attention to the principles of refining and compounding of lubricating oils and more careful study of their protection while in service.

It is, in fact, generally conceded that if contaminating foreign matter can be kept out of an oil film the ability of this latter to perform its intended function will be more readily assured.

Viscosity or body in the lubricating film is not as essential where normal bearing temperatures are involved as was formerly expected. Flood lubrication, together with development of the oil film at the point of minimum pressure have proven to be of far more consequence in the maintenance of an adequate film of lubricant throughout the bearing clearance space.

Perhaps the most outstanding examples in this regard have been brought out in connection with the steam turbine, Diesel engine, electric car journal and textile spindle. Operation of these elements involves high speed as in the case of the textile spindle, frequently high temperature in the steam turbine bearing, considerable pressure in the Diesel engine bearings and marked possibility of contamination of the lubricant in the car wheel journal box.

These have always been the source of considerable trouble in the development of effective lubrication. It has only been natural, therefore, that they should be studied by specialists directly interested in reduction of power consumption and more positive operation in the respective industries.

POWER CONSUMPTION BY ELECTRIC RAILWAY EQUIPMENT

The extent to which power consumption has been studied in the electric railway industry is interesting indeed; particularly the research which has been carried on by the United Railways and Electric Company of Baltimore.*

The results of this research are of decided interest, for they indicate that electric railway journal, axle and armature lubrication can be markedly improved by the adoption of principles of lubrication which involve adequate means of preventing entry of abrasive foreign

*See article on lubrication presented before the American Electric Railway Engineering Association, 1928, by Dr. W. B. D. Penniman, Consulting Chemist.

matter into the journal box, and the use of an oil which has been so refined as to give the maximum of lubrication protection with the minimum of friction.

The Ideals in Journal Lubrication

Journal lubrication has been the subject of

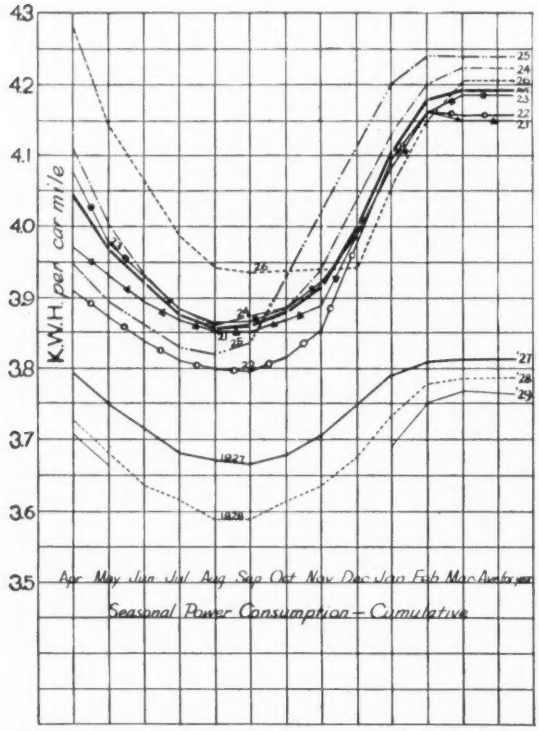

Fig. 1—Seasonal power consumption chart of the United Railways & Electric Company, showing the substantial reduction in power attained by study of improved methods of lubrication and oil protection.

discussion among electric railway operators virtually since the advent of the street car, for regardless of the manner of journal box construction it has been practically impossible to prevent entry of water, dust, sand and other non-lubricating impurities.

As a result, the waste-packed journal bearing has come to be regarded by many as involving one of the necessary problems of electric railway operation—a problem which includes the treating, handling, storage and application of waste, the machining of tapered journals and the re-babbitting of bearings. All of this will normally require considerable expense, for each process has a decided influence upon the subsequent extent to which hot boxes will be eliminated and car-mileage increased.

There are certain outstanding ideals in electric car wheel journal lubrication which have always been the goal of the management. They include:

1. Reduction of power consumption,
2. The maximum economy of oil,
3. Elimination of time and expense for waste saturation,
4. Increase in car speeds, especially on get-away,
5. The reduction of overhaul or shop expense wherever practicable,
6. The maximum protection of the waste from entry of contaminating foreign matter,
7. Complete retention of oil within the journal box.

Nature of Power Losses

The recoverable power losses which will be encountered in the operation of electric railway equipment may be grouped into two classifications, viz.:

(a) Those direct frictional losses which are developed in the equipment bearings, and

(b) Those power plant losses which may be attributed to excessive peak load demand on generating equipment.

As a general rule, the former will be the most direct factor in the occurrence of abnormal power consumption, and they will usually offer the most tangible field for the effecting of appreciable economies. They will normally be considerably greater in winter than in summer.

In regard to peak load, it is well to state that in the average utility, cost of purchased power in particular will be markedly increased where peak load requirements are exceeded to any extent. It is, therefore, to the interest of the operator to so direct the handling, lubrication and maintenance of his power consuming equipment as to entail as low a power demand as possible.

Effect of Friction

In this regard, it must be remembered that frictional power losses will have a direct effect upon the peak load; in fact, their reduction will in general be reflected by a considerable reduction in the peak load requirements. They are, of course, directly influenced by the degree to which effective lubrication is maintained. All this has been corroborated by the research mentioned above.

It is interesting to note that, by use of adequate means of preventing development of friction losses, a material increase in car speed is also attainable. Tests on equipment where lubrication has been studied, involving reduction in viscosity requirements and the use of leather oil seals, have indicated that an increase of approximately fifteen per cent in accelerating and free-running speeds can be reasonably expected.

This increase has, furthermore, been brought about with the same degree of operating safety as prevails when heavier oils and less effective dust guards are used.

PROTECTION OF LUBRICATION

In line with the attainment of effective lubrication of practically any type of machinery, the first thought in the above mentioned study was to develop a positive means of preventing entry of abrasive non-lubricating matter.

It has been generally observed that this latter will be present to a high degree adjacent to the wheel hubs on any electric railway system. Especially will this be true where tracks are laid flush with the pavement, to give rise to possible washing of water, and disturbance of road dust or metallic grindings from brake shoes.

Wooden Dust Guards Inadequate

Prior to the development of the leather cup type of oil seal, as illustrated in Fig. 4, it was general practice to use the old-fashioned wooden guard, developed years ago. In fact, this latter is quite generally used today on properties which have not as yet studied the application of the leather seal.

It is practically impossible for a wooden dust guard to insure absolute exclusion of dust, metallic particles worn from the brake shoes, and other abrasives, at the back of the journal box. As a result, wear of the fillet at the back of the journal seat must normally be expected due to entry of such abrasives.

The wooden type of so-called dust-guard also has other disadvantages which are virtually impossible to overcome. It is, of course, comparatively easy to make an installation of such a guard, but after a short period of service, during which a considerable accumulation of dirt may have been built up in the dust-guard slot or around the journal, removal of the guard is practically impossible without complete destruction, for the guard is exposed to wheel wash after rains, etc., which will give rise to swelling or expansion of the wood.

It is also important to mention that the hole in such a dust-guard, through which the journal passes, will always tend to wear out-of-round, see Fig. 3, enlarging to such an extent as to fail more or less entirely in the exclusion of dirt or water from the journal box, and the prevention of oil leakage.

The oily appearance of wheel hubs is indication of this latter. It is surprising how generally this condition will exist on properties where such types of dust guards are employed.

Leather Seal Insures Tightness

The leather oil seal, on the other hand, has proven to be capable of absolute contact between its inner surface and the journal. It is, therefore, worthy of its name, for it maintains a tight seal around the entire circumference of the journal to not only prevent entry of dirt and water, but also render loss of oil practically impossible.

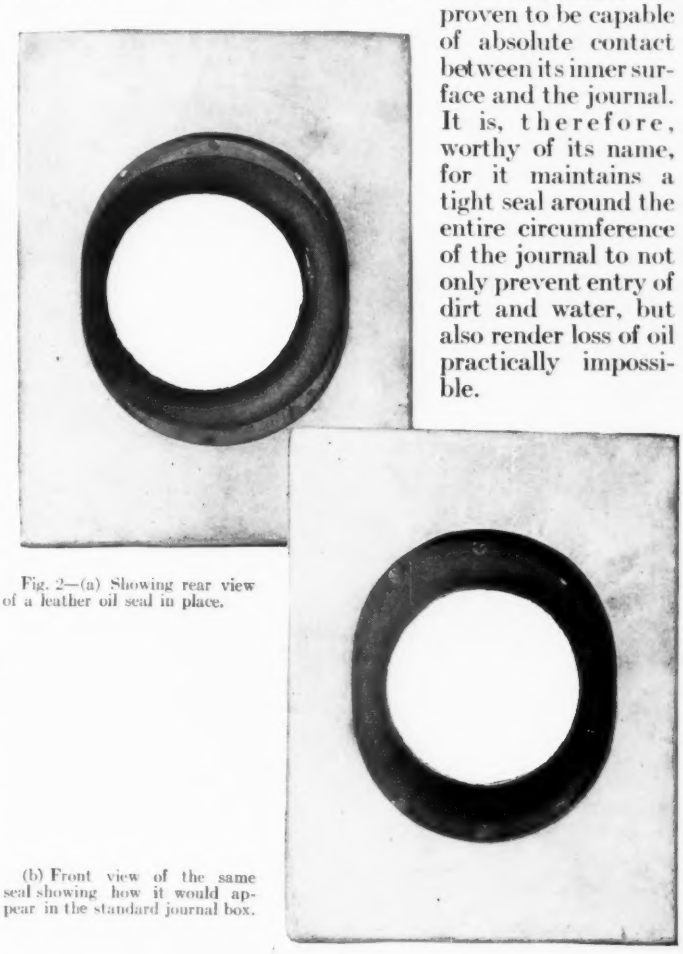

Fig. 2—(a) Showing rear view of a leather oil seal in place.

(b) Front view of the same seal showing how it would appear in the standard journal box.

As a result, it is safe to say that this type of seal is an absolute preventive against starvation of lubrication, provided the proper amount of oil has been applied to the waste in the journal box in the beginning.

Obviously, if there is no place for the oil to leak to, it must perform its intended function of maintaining complete film lubrication between the journal and the bearing.

Size of Seal

It is evident that, in view of the variation which will normally exist in the size of journals, such an oil seal to be effective must be of a size commensurate with that of the journal to which it is to be applied. It has been proven that the inner diameter of the sleeve portion should be approximately one-eighth of an inch

less than that of the journal over which it is to be used.

By proper planning of shop practice, however, it should be comparatively easy to store seals according to size, so that immediately on

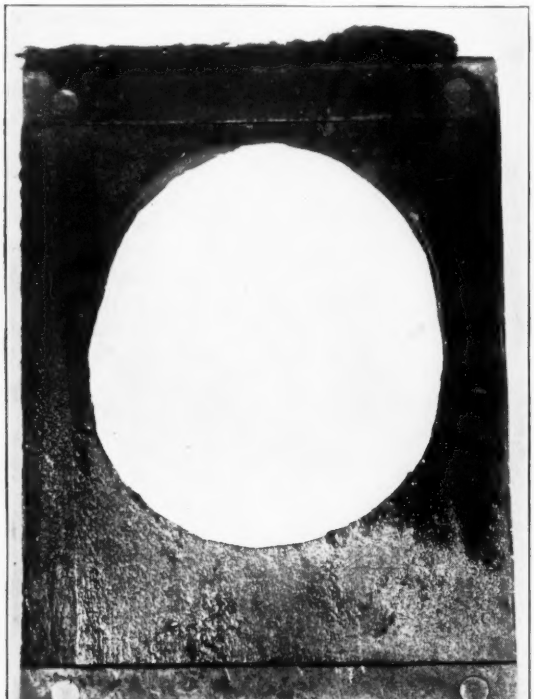

Fig. 3—Illustration of an old-style wooden dust-guard taken from service. Note in particular the large elliptical shape of the opening. Naturally, this will permit free entrance of abrasive material and allow oil to leak out.

calipering a journal, the right size seal can be obtained.

It is important to remember, however, that the above will only apply to undersized journals or those which have been worn down by reason of having become tapered during operation. Where the seal is designed to fit the shoulder of the journal, only one size of seal will be required, inasmuch as the diameter of the shoulder will usually not vary to any extent.

Installation of the Oil Seal

Leather oil seals should be applied to journals after all parts have been properly cleaned, and prior to packing with clean, saturated waste. It is, in fact, impossible to apply them without removal of the journal box.

With the box ready for installation of the seal, this latter, with the metal plate to which it is riveted, can then be inserted through the hole in the outer wall, with the sleeve projecting into the box. The purpose of this plate is to hold the seal in rigid position, and to protect it as far as possible against damage from external foreign matter.

Benefit on Condition of Used Waste

One of the most obvious advantages of the leather oil seal is indicated by the average appearance of used waste in any journal box wherein such an installation has been employed for any length of time.

Cases have been known where low viscosity oils have been used, where the original colors of the yarn in the waste have been clearly visible after a considerable period of operation.

The fact that oil was so little discolored as to have no extensive effect upon the coloring of the waste, is absolute evidence that the presence of dirt or other discoloring or contaminating foreign matter was negligible.

It is interesting to note that elimination of entrance of dust and abrasive matter will markedly lengthen the life of both the bearings and journals.

WASTE

In the handling of waste in electric railway service, the type, life, durability, inspection, time of removal and treatment must be considered.

From the viewpoint of type, it is of interest to say that the use of one hundred per cent wool waste is becoming standardized upon today, as indicated by the specifications of the American Electric Railway Association.

It has been developed that one hundred per cent wool waste will show the best resiliency and the best ability towards uniform retention of oil and equal distribution to the journal. In other words, it enables the most uniform degree of capillary action.

Factors Affecting Durability

Regardless of the type or original grade of the waste, however, it is safe to say that its probable life and durability will largely depend upon the extent to which it may become contaminated with non-lubricating foreign matter and the amount of handling it must receive at the time of cleaning and resaturation in order to remove such contaminating or abrasive foreign matter.

It is reasonable to expect that if this latter is comparatively low, the life of the waste, as well as its durability as an oil retaining and transmitting medium will be increased.

In view of the fact that the oil seal has proven to be an effective eliminator of dust, dirt and abrasive matter in journal boxes, it is apparent that it will also prolong the life and durability of the waste therein.

Another factor which aids in extending the

useful life of the waste has been the adoption of low viscosity car oils. As a general rule, these latter will penetrate the waste more readily with less tendency of promoting "waste grabs."

Inspection of Waste

Mention has already been made of the fact that journal boxes which have been equipped with the leather oil seal and supplied with low viscosity oils have shown the original color in the waste strands after an extended period of operation.

It is evident that this is an extremely valuable asset at the time of inspection, for it will enable the mechanic to actually observe the extent to which positive lubrication is being maintained by the waste and its oil content. Obviously, if the waste has an oily feeling to the touch and is not discolored by dirt, there is comparatively no danger of impaired lubrication.

As a result, it is reasonable to expect that no appreciable wear has taken place either on the journal or bearing surface. The normal procedure in such a case would, therefore, be to add a small quantity of oil as insurance of continued lubrication, and close the box until the next period of inspection.

Actual experience has shown that the probability of development of a hot box where journal bearings are so lubricated is comparatively negligible.

Waste Treatment

While it has been indicated on the property of the United Railways & Electric Company that the use of low viscosity oils will materially extend the life of the waste, there will always be a certain amount of used waste which must be reclaimed. This will be especially true while journal boxes are being converted to the use of such oils.

There will be one outstanding feature, however, regardless of the above, i.e., the use of low viscosity oil for waste saturation will materially reduce the time of submergence.

Tests have indicated, in fact, that it is possible to attain a satisfactory degree of saturation by submerging the waste in such an oil for approximately one to two hours. After that, it is only necessary to allow it to drain about an hour before it is ready for use.

This is, without a doubt, a decided advantage over the heretofore accepted method of waste saturation wherein the waste should be submerged for approximately forty-eight hours, and then drained for twenty-four hours more.

Fig. 4—Showing the latest type of oil seal leather for general application.

This extended period of time, however, is necessary due to the higher viscosity of the oils involved and the greater difficulty with which they penetrated the waste strands.

Packing Journal Boxes

With the leather oil seal and low viscosity oil, the packing of journal boxes has been developed into a more simple matter than formerly, in view of the fact that no so-called dust rings are necessary.

The normal procedure is to take the waste, after it has drained to the extent that it shows an ample content of oil when squeezed, and pack it tightly into the box until the space below the journal is filled to its capacity.

The end of the journal is left exposed, thereby reducing the amount of waste required and leaving an oil well to insure abundant lubrication. Oil is then poured in on top of the waste until a pool appears above the waste at the front end of the journal.

There will be no possibility for escape of this oil due to the tightness of the leather oil seal. Furthermore, if the box has been properly packed there should be no strands of waste hanging outside to serve as a means of siphoning off the oil. In final, with the journal box cover properly adjusted and bolted down, entry of dust at the front of the box will be prevented.

Waste Deterioration

The marked extension in the life and dur-

ability of waste used in this system of lubrication as brought out by the observed requirement of approximately four pounds per car each year, can of course be attributed to the lubricating characteristics and lower viscosity

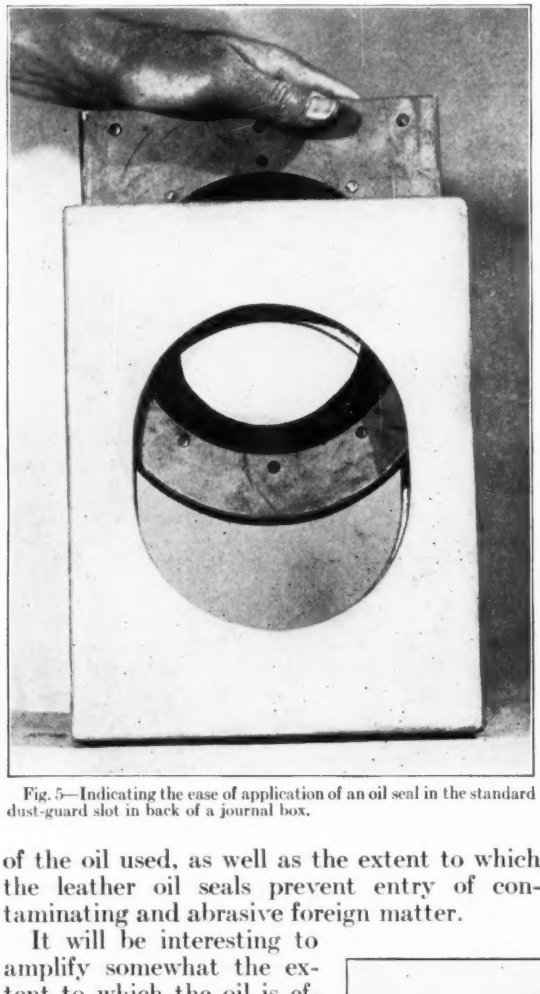

Fig. 5—Indicating the ease of application of an oil seal in the standard dust-guard slot in back of a journal box.

of the oil used, as well as the extent to which the leather oil seals prevent entry of contaminating and abrasive foreign matter.

It will be interesting to amplify somewhat the extent to which the oil is effective in this regard. By reason of its greater fluidity and its increased lubricating ability, it will lend itself more readily to capillary action. As a result, it will flow more freely through the waste and remain more positively at the point of contact between the bearing and journal.

Condition of Used Waste

Examination of journal boxes wherein waste has been used for a considerable period of time has very frequently indicated, as already stated, that the actual color of the waste strands has been still visible.

Furthermore, the waste itself will be resilient, free of matting and possessing equal distribution of oil throughout its body.

Contrast this with the average journal box wherein there is no adequate means of protection in the form of a leather oil seal to prevent entry of water and other foreign matter. Usually, the waste will be soggy and heavy. It will very often be glazed, due to increased bearing temperatures, and will be matted to such an extent that, very frequently, it will be regarded as not worth the trouble of washing and resaturation.

Whether or not the value of the waste has been actually destroyed may be a point of contention. Normally, however, the oil house attendant will be the judge in this matter and will be prone to follow the easiest course; that is, to junk such waste and replace it with new product. Of course, this will lead to an increase in expense.

OIL HOUSE FACILITIES

Where adequate means are employed for protection of lubricants in service, a decidedly favorable reaction will usually be observed upon the costs of storage and handling of lubricants. This has been found to be especially apparent on electric railway systems using low viscosity oils. The outstanding points will involve

(1) Reduction in the volume of oil to be stored,

(2) Marked decrease in labor for oil and waste handling,

(3) Elimination of the necessity for heating both storage tanks and containers in cold weather,

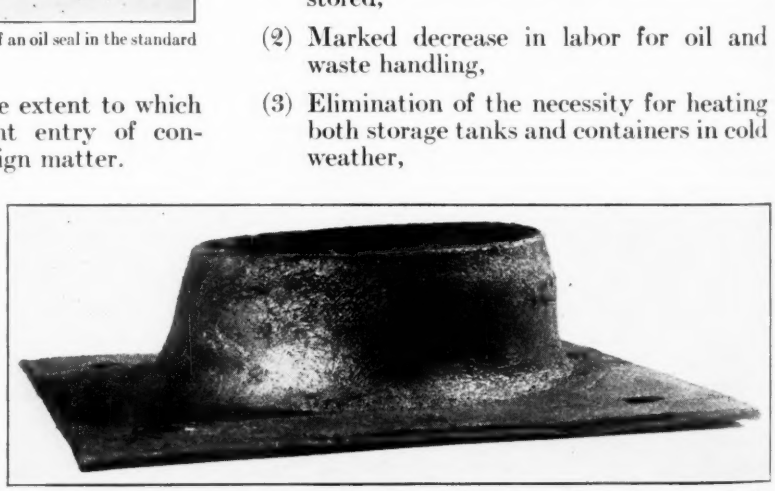

Fig. 6—The durability of a leather oil seal is indicated above, this one having been in service for two years. Note how the flexibility of the leather permits adjustment to movement of the journal without destroying the seal.

(4) Greater cleanliness and, consequently, less possibility of the oil becoming contaminated.

Oil house management is one of the most important factors in the maintenance of

economical and effective lubrication. It is obvious that every precaution must be taken to keep the lubricants in as nearly as possible their state of original purity. The more readily these can be handled, the less possibility there will be for contamination. Furthermore, where they are comparatively light in color, they will show contamination sooner than dark-colored opaque oils.

Light Colored Oils Advantageous

This matter of color has proven to have a peculiarly psychological effect upon oil house and shop personnel. Where oils are dark and comparatively heavy, the attitude of the average employee will be to show an aversion to handling saturated waste or getting more oil than absolutely necessary on his hands, for it will normally amount to a messy job.

Very frequently, in his efforts to keep his hands clean in handling such an oil or waste saturated with same, dirty sticks will be used, waste will be allowed to drop into the dust, or buckets of oil will be slopped around in an unnecessary manner.

With the lighter colored, low viscosity oils, however, it is practicable to use a spout can instead of a bucket in the pits. The purpose of the spout can, of course, is to keep the oil as clean as possible, for in view of its dirt removing characteristics, there will be a tendency for operators to dip their hands and packing tools into a bucket of such oil for the purpose of cleaning. This, of course, would lead to oil contamination. Hence, the advantage of the spout can.

On the other hand, actual handling of waste saturated with light oil is not at all objectionable, in view of the fact that the waste does not become bound together in a gritty, sticky mass to require extensive pulling apart.

As a result, whether in packing a box with freshly saturated waste, or renewing oil when a car is pulled into the shop for any reason, the work will always be welcomed by the men, for their former troubles in the handling of heavier oils and sticky masses of waste will be eliminated.

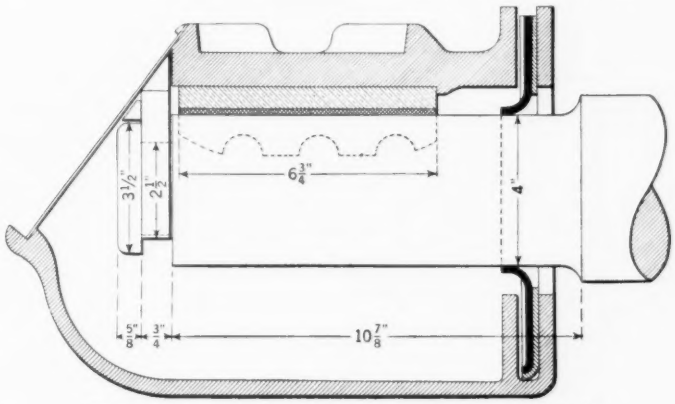

Fig. 8—Cross section of a standard journal box, showing the leather oil seal in heavy black, and the relative location of the bearing above the journal.

Reduction in Volume of Waste

In view of the degree to which the life and durability of waste can be extended when saturated with low viscosity oils and protected by leather oil seals, it is obvious that marked reduction in the amount of waste in use on any system will be possible. The remarkably low requirement of approximately four pounds per car each year (as already mentioned) has been indicated where such means of lubrication have been fully developed.

This, of course, will extensively reduce the volume of waste to be stored, with consequent reduction in the cost of stock on hand; at the same time it will release storage space in the oil house for other purposes.

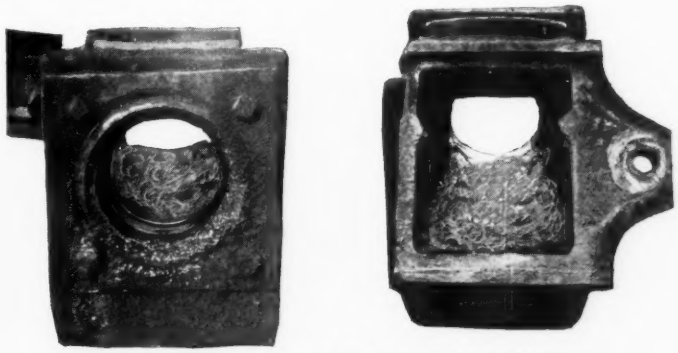

Fig. 7—Front and rear view of a journal box equipped with oil seals. Note in particular the amount of dirt accumulated on the back of the box which the oil seal keeps out, and the clean condition of the waste strands.

Elimination of Heating Facilities

On account of the low viscosity and pour test of the oils involved at no time will there be necessity for heating prior to pumping of such an oil into oil house storage tanks. For these same reasons, the use of heating coils in connection with storage and waste saturation tanks can also be eliminated.

Elimination of heating requirements might frequently be an outstanding advantage in shops where there might be no facilities for steam power generation and where electricity might have to be used for this purpose.

Fig. 9—The condition of the bearings, as shown above, is indicative of the value of preventing entry of dust and dirt and enabling the waste to more effectively maintain a suitable oil film.

Treating Tank Requirements

It has been stated elsewhere in this article that by the use of low viscosity oils the time for waste saturation will be reduced to approximately one to two hours.

When we contrast this with the twenty-four to forty-eight hour requirements when using heavier viscosity oils, it is reasonable to expect that fewer waste saturation tanks will be required. The extent to which this might affect oil house expense would, of course, depend upon whether a new installation were being made or whether a road was being converted to such products.

In a new oil house installation, it would be practicable to estimate very closely the tank capacity required. In an existing oil house, however, such conversion might lead to a number of tanks being released for other purposes.

THE ADVANTAGE OF LOW VISCOSITY

An important factor in these developments has been the extent to which low viscosity oils have been proven to be adaptable to electric railway equipment. In fact, the idea that a viscosity of from 400 to 600 seconds Saybolt at 100 degrees Fahr. is necessary, dependent upon climatic temperatures, has been more or less disproved by reason of the improvements in operation which have been indicated by the use of an oil with as low a viscosity as 38 seconds Saybolt at 100 degrees Fahr.

It is apparent, that by the prevention of entry of abrasive foreign matter, the oil is more nearly able to perform its intended function of maintaining lubrication. It must be amply protected in service, however, by a suitable oil seal, as mentioned heretofore.

The Duty Involved

With heavier lubricants, a dual function is necessary, especially where dirt or grit may enter to any extent. Under such conditions, the oil must not only reduce solid friction but, also, by virtue of its viscosity, it has to actually surround each particle of foreign matter in order to prevent contact of the latter with the surfaces of the bearing and the journal.

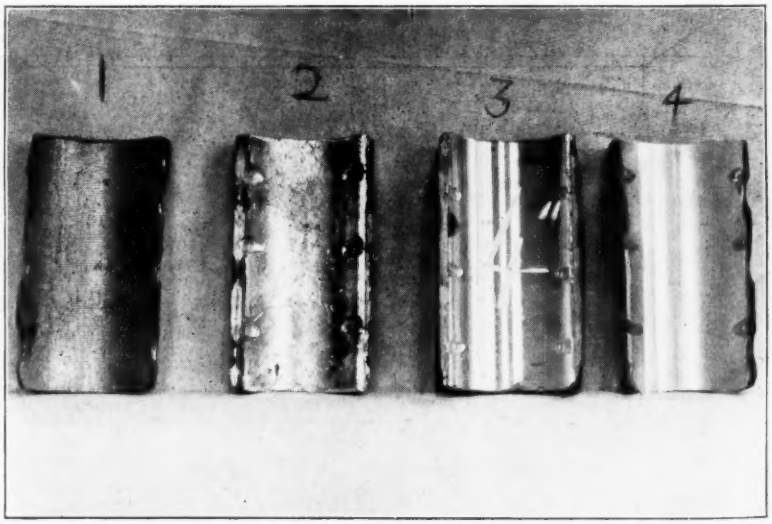

Fig. 10—A bearing in the course of development. (1) Indicates rough brass, (2) Rough lining, (3) Turned lining, (4) Service lining.

As a result, as the foreign matter content increases, the fluidity of such an oil may tend to decrease. In other words, there will be more resistance offered to capillary action as well as to flow to the bearings.

This could normally be expected to have a marked effect upon the power consumption, especially when starting. It could, furthermore, be expected to be more apparent during cold weather operation, even though the original oil might have a zero pour test.

The All-Year Round Feature

In this regard, it is interesting to note that in view of the fact that the low viscosity oil developed for such service will always have a -0 pour test, it will automatically become an all-year-round oil. In other words, the necessity for seasonal changing of oil, which is so often objectionable, will be eliminated.

Viscosity Also a Factor in the Power Plant

The use of lower viscosity oils where ample means are provided for their protection, is not a new idea.

The Steam Turbine

The Steam Turbine, for example, is an outstanding case of where the viscosity of bearing

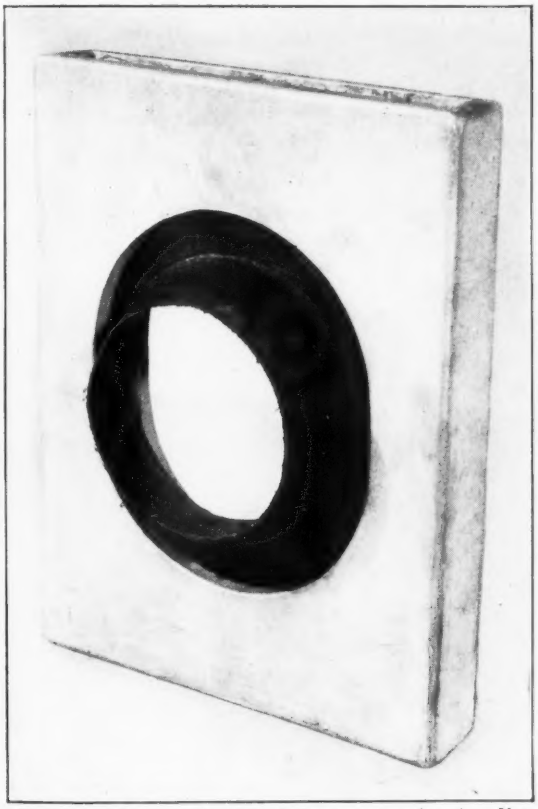

Fig. 11—Another view of an oil seal after two years of service. Note its perfect condition.

lubricants has been materially decreased during the past few years, until today highly refined straight mineral oils of 140 to 150 seconds Saybolt viscosity at 100 degrees Fahr. are functioning with very high efficiency.

On the other hand, the steam turbine industry has always endeavored to filter or purify lubricating oils during operation. Furthermore, the bearings of the modern steam turbine are always designed with a series of glands, to

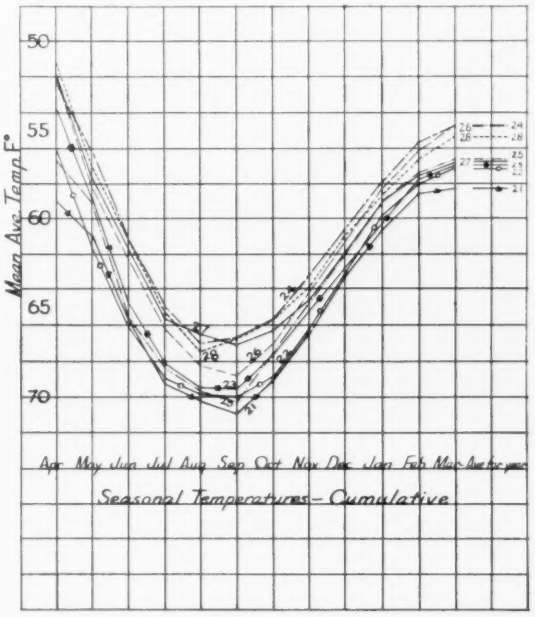

Fig. 12—Seasonal temperature chart, showing range of operating conditions on property of the United Railways & Electric Company.

prevent entry of water or abrasive foreign matter as far as possible.

The Diesel Engine

The Diesel engine has also been studied in this regard, to the extent that, whereas heretofore oils of from 500 to 750 seconds Saybolt viscosity have been considered necessary for bearing service, today better run-in results are indicated if a 200 viscosity lubricant is used.

It is interesting to note that in connection with the internal combustion engine, viscosity of the bearing oil will have a material effect on machine power consumption. In other words, by decreasing the viscosity within reasonable limits, increased power output per unit of fuel burned may be expected. This might, of course, be accompanied by an increase in lubricating oil consumption, but research indicates that this latter will be outweighed by the potential increase in power available.

Elimination of Partial Film Lubrication

Wherever comparatively heavy oils of high pour test may be used on electric railway equipment, there may be the possibility of impairment of the lubricating film, due to entry of the waste strands into the bearing clearance and hindrance of oil circulation.

"Waste grabs" of this nature have normally been found to occur in cold weather where a comparatively highly contaminated oil was used, and where the waste itself had absorbed an extensive amount of dust, dirt and metallic particles. It is almost impossible to judge the extent to which waste may become contaminated in this manner, where there is no effective means provided for sealing of the bearing ends.

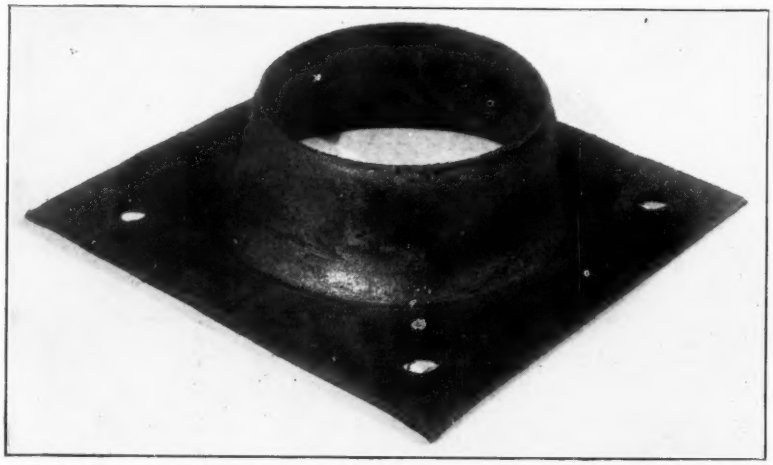

Fig. 13—View of a leather oil seal removed after two years of service. It is interesting to note that such an oil seal can be removed and re-inserted in a journal box without damage.

When this occurs, simply renewing the waste will be inadequate, for wear of the journal and bearing surfaces will usually have taken place to such a marked degree as to necessitate installation of a new bearing, or even regrinding and finishing of the journal itself.

Where there is provision for adequate protection of the oil from contamination, however, actual operation has proven that all the above will be largely eliminated. Consequently, the possibility of overheating will be reduced, and the oil will feed more readily through the waste, to thereby more nearly perform its intended function.

Reduction of Tapered Journals

It has furthermore been proven that where a bearing is in good condition and is properly matched to the journal surface, if positive lubrication can be maintained the wear on both surfaces will be uniform. This has been very clearly observed wherever low viscosity oils in connection with a proper leather oil seal has been used. In fact, tapered journals have been rarely found.

Naturally, this should be another distinct point in favor of such means of lubrication, for it indicates that the machine shop practice of regrinding and finishing tapered journals will be seldom necessary.

Development of Running Fit

Another point which will be of particular interest to the master mechanic or machine shop foreman is that by use of scientifically prepared lubricants of a viscosity commensurate with the operating requirements, running fits will be obtained in a comparatively short space of time.

It is reasonable to expect that this is brought about by virtue of the fact that the nature of the oil enables the bearing metal to wear into accurate formation with the journal surface more readily than where there is possibility of entry of dust or dirt, or where the viscosity of the oil may be appreciably higher.

Indication of Trouble

In the electric railway industry, the usually accepted indication of bearing trouble has been the hot box. Where an oil of from 400 to 600 seconds Saybolt viscosity at 100 degrees Fahr. is used, considerable rise in temperature may normally occur before any appreci-

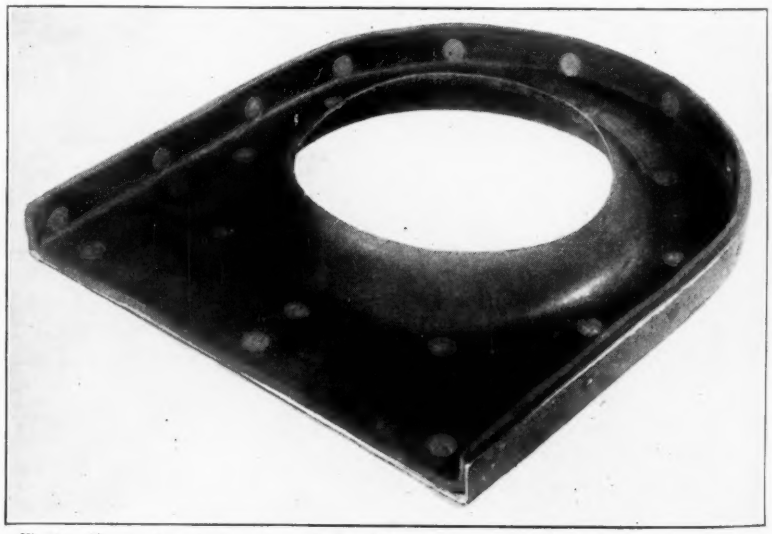

Fig. 14—Showing how the latest type of oil seal is riveted to a metal plate to facilitate installation.

able amount of vaporization will be noticeable.

Frequently, in fact, by the time such vaporization does begin, bearing temperatures will be rising so rapidly as to cause the waste to actually burn as soon as the cover of the journal box is removed. The only procedure after such an occurrence is to pull the car into the shop and subject the journal box, bearing and journal to inspection and repair. Obviously, this will mean a car tie-up with accompanying expense for repair and time lost.

Where oils of low viscosity are used, however, marked vaporization will develop at comparatively low temperatures. These latter will be sufficiently below the danger point to serve as an alarm signal before serious trouble can occur. Normally, such a condition can be readily overcome by allowing the journal box to cool down and then pouring in a small quantity of oil to increase the degree of saturation of the waste.

Fig. 16—Rear view of an oil seal showing size stamped thereon for identification.

Theory Involved

Inasmuch as effective lubrication has been the ultimate ideal in the development of the research work referred to in the beginning of this article, a word in closing, to give a clearer understanding of the meaning of effective lubrication, will be advisable.

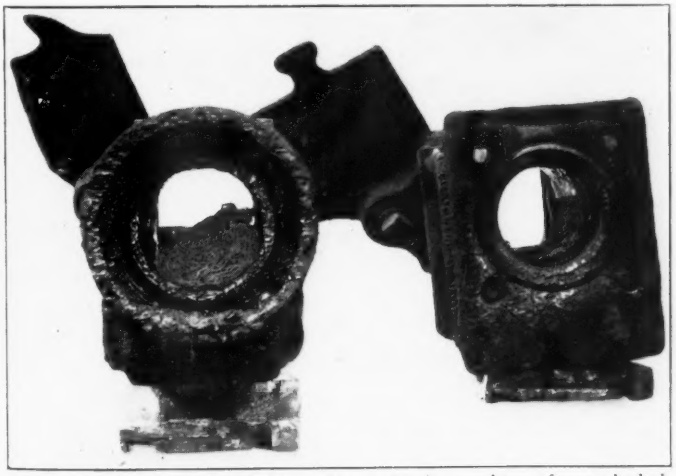

Fig. 15—Showing a round-backed type of box and an improved type of square backed box. In each case note the accumulation of dirt which would gain entry to contaminate the oil if a leather oil seal were not employed.

Essentially it means the reduction of solid-friction or metal-to-metal contact between any two moving elements, in such a manner as to result in the minimum of wear or loss of power in the maintenance of motion or operation.

This is brought about by the use of a lubricant which will be capable of maintaining a protective film between the wearing surfaces. This film must, of course, be of fluid nature in order that it may readily penetrate throughout all clearance spaces.

By means of this film solid friction is supplanted by fluid friction. In other words, those microscopically high spots which exist on practically any metallic surface, regardless of its polish or machining, are prevented from coming in contact with each other.

If there is adequate fluidity within the lubricating film to facilitate ready conformation to the motion between the solid surfaces involved, a minimum of fluid friction should be developed. In other words, the film should most effectively serve its dual purpose in:

1. The elimination of metallic wear and
2. The prevention of abnormal temperature rise.

The degree of success attained will depend upon the relative fluidity or viscosity of the oil which constitutes the lubricating film. A lubricant does not just lay in the clearance space and allow the moving part to slide over it, much as a sled runner would pass over smooth ice. Instead its component particles are in constant motion with respect to each other and to the metallic surfaces involved. If these particles move sluggishly, that is, if the viscosity is too high in accordance with the operating speed and pressure involved, they will tend to develop abnormal friction within

the film itself. This will be indicated by rise in bearing temperatures and increase in power consumption.

In other words, the purpose of lubrication will be more or less defeated.

Fig. 17—Rear view of such a seal, showing the circular depression therein which serves as an added means of preventing entry of dirt.

The Lubricating Film Illustrated

An idealistic picture of an oil film (Fig. 18) would show:

A—As the upper part, and
B—As the lower part,
C—Being the upper metallic surface, and
D—The lower metallic surface.

The distance between C and D is called the clearance.

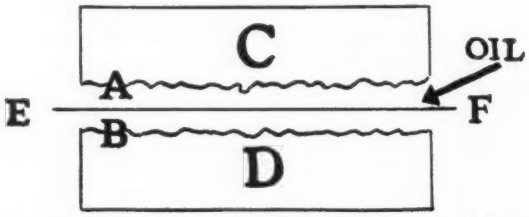

Fig. 18—Line sketch of a lubricating film. See accompanying text for explanation.

Assuming that the oil film is divided into two parts along the line E F. Oil layer A fills up the slight crevices of the metal surface above it and sticks to that metal surface.

Oil layer B does the same for metal surface D.

Now, if the upper metallic surface is moved to the right, the oil layer, which is in direct contact with it, will move along with it and slide with it over oil-layer B.

There will then be two smooth surfaces (of oil), one sliding over the other, instead of two comparatively rough surfaces of metal sliding over each other. Motion will be accomplished easily and there will be no metal-to-metal contact. In other words, no solid friction.

But actually the oil will not be split into two layers with a clean break between them.

It is believed by some to be split into many, many layers, somewhat like a deck of cards, with some resistance between each layer and more resistance due to the molecules of the oil moving from one layer into another.

And when there is any resistance to motion, heat is generated and the faster the motion, the greater the heat.

SUMMARY OF ADVANTAGES

The advantages which are, therefore, attainable by the adoption of adequate means of oil protection in the form of leather seals, and the usage of low viscosity oils will be:

1. Reduction of power consumption due to the reduction in internal friction in the oil itself.
2. Increase in speed, especially on get-away, due to reduced viscosity.
3. Reduction of the amount of waste saturation necessary.
4. Economy of oil due to elimination of leakage.
5. Greater ease and speed in waste saturation.
6. Earlier indication of bearing trouble with more opportunity for prevention of hot boxes and damage to bearings and journals.
7. Adaptability to all climates regardless of weather conditions or temperatures.
8. Lengthening of journal and bearing life and reduction of journal box leakage.

In final, it is well to state that the colder the climate, the more apparent will these advantages become.

* * * *

CORRECTION

Through a regrettable error, Figure No. 6, Page 53, of the May, 1929, issue of "LUBRICATION", showed a view of the Telsmith Primary Breaker, up-side-down. Our humble apologies are offered to the Smith Engineering Works, and it is hoped that this mention will correct any misunderstanding that may have been gained by our readers.

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